DOCUMENT RESUME

ED 331 807 SP 033 036

AUTHOR DeRuiter, James A.
TITLE The Development of Teachers' Pedagogical Content Knowledge.
PUB DATE 3 Apr 91
NOTE 18p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, April 2-6, 1991).
PUB TYPE Speeches/Conference Papers (150) -- Viewpoints (Opinion/Position Papers, Essays, etc.) (120)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Course Content; Developmental Stages; *Educational Theories; Elementary Education; Exceptional Persons; Graduate Study; Higher Education; *Holistic Approach; Individual Development; Learning Strategies; Piagetian Theory; Special Education; *Teacher Education Programs; *Teacher Improvement; Teaching Experience; *Teaching Methods
IDENTIFIERS *Teacher Knowledge; Vygotsky (Lev S)

ABSTRACT

Teachers' pedagogical content knowledge (PCK) may be regarded as developing through several major phases that require time and guided practice. This paper describes a graduate class titled "Learning and Development in Exceptional Individuals" in which teachers learn about pedagogy and tie it to content teaching as they work with children. The course is structured to be consistent with Piagetian and Vygotskian concepts of the nature of learning and is closely linked to a holistic view of teaching. The interactive teaching approach used in the course recognizes that knowledge is constructed in a social context where each individual's learning is significantly affected by the ideas and actions of others. The paper also describes proposed phases of teachers' development and some characteristics of each phase based on analysis of video tapes of the teachers working with children, teachers' written comments, and follow-up interviews with the teachers. As these information sources have not yet been completely analyzed, the assertions about the data are tentative. It is suggested, tentatively, that teachers may be helped to develop PCK if they: (1) make their epistemology explicit; (2) study students' specific thinking and learning strategies; and (3) understand learning as a holistic process that proceeds through qualitative transformations or phases. (Author/AMH)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED331807

The Development of Teachers' Pedagogical Content Knowledge

James A. DeRuiter

Division of Special Education

University of Northern Colorado

Greeley, Colorado 80639

Paper presented at the

American Educational Research Association

1991 Annual Meeting

April 3, 1991

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

J A De Ruiter

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SP033036

BEST COPY AVAILABLE

Abstract

Teachers' pedagogical content knowledge (PCK) may be regarded as developing through several major phases that require time and guided practice. This paper describes a graduate class in which teachers learn about pedagogy and tie it to content teaching as they work with children. The paper also describes proposed phases of teachers' development and some characteristics of each phase based on analysis of video tapes of the teachers working with children, teachers' written comments and follow-up interviews with the teachers. Issues regarding the development of pedagogical knowledge are discussed in the context of other aspects of teachers' learning. It is suggested, tentatively, that teachers may be helped to develop PCK if they 1) make their epistemology explicit, 2) study students' specific thinking and learning strategies and 3) understand learning as an holistic process that proceeds through qualitative transformations or phases.

INTRODUCTION

This paper will be highly speculative with an eye toward stimulating some ideas about teaching teachers to teach in a way that sparks some suggestions from the audience. I will base my remarks on a teaching experiment that I am carrying out with my students, but I will go considerably beyond the data I have collected and analyzed so far. I do this, in part, because I hope for some suggestions from others. I also do this because I haven't finished with my data collection and analysis so I can't report on it. I will take a qualitative approach, making assertions about the data I have analyzed so far, but you should understand that I have not fully confirmed these assertions and some may be disconfirmed eventually.

The paper has three parts. First, I will describe the teaching situation that I am using for data collection. Next, I will talk about the data I am collecting. Finally, I will present some assertions about these data and tie them back to the concept of pedagogical content knowledge.

THE TEACHING SITUATION

The primary course I have used to study teachers' development is a graduate course titled "Learning and Development in Exceptional Individuals." Nearly all of the students who take this course are in Masters degree programs in special education, including programs for teaching the gifted as well as students with mild to profound affective, cognitive, communication, vision and hearing needs. Most are experienced teachers with at least two years of work with exceptional children.

Theoretical Basis For The Class

To the degree that special education programs are known for having a common theoretical basis, that basis is generally rooted in logical positivism, empiricist epistemology and a reductionistic approach to teaching and learning. The approach in our department is quite different. Our program, including this required class, is structured to be consistent with Piagetian (Piaget, 1968/1970, 1970; Wadsworth, 1978) and Vygotskian (Vygotsky, 1978, 1986, 1987; Newman, Griffin & Cole, 1989; Rogoff, 1990) concepts of the nature of learning and is closely linked to a holistic view of teaching. We have developed an overall program structure and sets of methodological principles and strategies based on these theories. I will call this view "holistic constructivism" (Poplin, 1988b, p. 402), following Poplin's suggestion.

Empiricism

Holistic constructivism contrasts sharply with an empiricist view, in which knowledge is regarded as an accumulation of specific facts. Empiricists see learning as taking in information that is contained in the environment (i.e., the minds and words of professors, a specific classroom that can be observed), a concept that numerous authors refer to as the received view of learning (Belenky, Clinchy, Goldberger & Tarule, 1986; Britzman, 1986; O'Loughlin, 1988). O'Loughlin (1988) summarizes as follows:

> This view...argues that all knowledge is objective and reducible to facts; that knowledge emanates from authorities or experts who can be relied upon to provide "the right answer"; that teaching is the transmission of knowledge from expert to novice and consequently that learning is the acquisition of objective knowledge: and that knowledge is a possession whose presence in all students, in the same form, can be assessed by means of standardized tests (p. 2-3).

Programs and classrooms are usually designed to make this "taking in" of information more efficient. We design programs to present information sequentially, fact by fact, from the less difficult to the more difficult. We design classrooms so that a knowledgeable expert can be in front of the room and impart knowledge to the less expert. An important consequence is that teachers come to think of "teaching as telling and controlling, and learning as absorbing and conforming" (O'Loughlin, 1988, p. 3).

Recently, teaching methods based on empiricism have been criticized for leading to fragmentation of knowledge, for not centering learning in action and experience, for overemphasizing content while underemphasizing learners' prior knowledge, needs and self-organizing, purposeful self-direction, and for promoting authoritarian teaching practices (Britzman, 1986; Heshusius,1984; Kamii, 1985, 1989; O'Loughlin, 1988; Poplin, 1988a & b). Some (Goodlad, 1983; Sirotnik, 1983) have gone so far as to suggest that teacher education, as typically done, specifically results in the opposite of what we want.

Instead of creative, active, involved learners we develop "dependence on authority, linear thinking, social apathy and hands-off learning" (Sirotnik, 1983, p. 29).

Holistic constructivism

Holistic constructivism is increasingly advocated in education. In my field, Poplin (1988a & b), Reid (1988b) and Rhodes & Dudley-Marling (1988) are among numerous authors who have emphasized the need for a more holistic approach as a basis for teaching and learning. Two of these authors (Poplin and Reid), among many others (e.g., Brooks, 1990; O'Loughlin, 1988; Resnick, 1989) emphasize the idea that learning should be regarded as a construction of the learner and that teaching should emphasize transformation, not acquisition of information. These authors provide extensive explanations of holism and constructivism and only brief explanations will be provided here.

Holism: Webster's defines holism as 1) the philosophic theory "that the determining factors in nature are wholes (as organisms) which are irreducible to the sum of their parts and that the evolution of the universe is the record of the activity and making of these wholes; 2) a theory or doctrine according to which a whole cannot be analyzed without residue into the sum of its parts or reduced to discrete elements." In this view, reality is made up of unified wholes that are not only a sum of their parts: Therefore, something important is lost when a whole is broken down into its parts, even when one accounts for each part. A holistic perspective implies that both parts and wholes are important but emphasizes relationships among diverse objects, events, ideas, people and cultures. Holism seeks inclusiveness, integration, wholeness, and connectedness even as it acknowledges and values diversity. Teachers with an holistic perspective seek to understand their students' uniqueness and personal meanings. They regard students as complete and whole persons even if some of their "parts" are less than perfect.

As a theory, holism was first formulated by Jan C. Smuts (1926), South African statesman of the first half of this century. Smuts believed that "Among the great gaps in knowledge those which separate the phenomena of matter, life and mind still remain unbridged. Matter, life and mind remain utterly unlike each other" (p. 2). His effort was to show how these three, the physical, biological and mental aspects of the real world, are actually a unified whole. Our existence as humans and our experience show that the three are unified, but we lack the knowledge to explain the union. Smuts summarizes his theoretical position as follows:

> Holism has been presented ... as the ultimate synthetic, ordering, organising, regulative activity in the universe which accounts for all the structural groupings and syntheses in it, from the atom and the physico-chemical structures, through the cell and organisms, through Mind in animals, to Personality in man. The all-pervading and ever-increasing character of synthetic unity or wholeness in these structures leads to the concept of Holism as the fundamental activity underlying and co-ordinating all others, and to the view of the universe as a Holistic Universe (p. 317). This is a universe of whole-making (p. 318).

Smuts (1926) notes that humans tend to analyze concrete situations by breaking them down into constituent parts, factors and elements. He recognizes this reductionism as a very useful procedure that has led to much successful understanding but says it has two risks: 1) In the original analysis something may have escaped so when we try to put it back together to understand the original, not all of the original parts are there; and 2) we confuse cause and effect. On this second point, he explains that the isolated elements or factors are thought to be the cause of the situation, but we started by trying to understand the complex situation and the isolated elements are merely the result of analysis. The isolated factors are regarded as the "real" but tend to be abstractions; the concrete, complex situation is relegated to a secondary position.

Holism points out that we make a mistake when we think about things, ideas and qualities as being absolutely discontinuous. Rather, things, ideas and qualities overlap and no relations among things, ideas and qualities would be possible if it were not for the "fuzzy edges" (Smuts, 1926, p. 17).

> ...[R]ound every luminous point in experience there is a gradual shading off into haziness and obscurity. A 'concept' is not merely its clear luminous centre, but embraces a surrounding sphere of meaning or influence of smaller or larger dimensions, in which the luminosity tails off and grows fainter until it disappears. Similarly a 'thing' is not

> merely that which presents itself as such in clearest definite outline, but this central area is surrounded by a zone of intuitions and influences which shades off into the region of the indefinite. The hard abrupt contours of our ordinary conceptional system do not apply to reality and make reality inexplicable, not only in the case of causation, but in cases of relations between things, qualities, and ideas." (Smuts, 1926, p. 17).

Holism combats our tendency to be excessively reductionistic and discontinuous. In so doing, a holistic perspective begins to change our interactions with students and our teaching. According to Poplin (1988b), "Holistic educators tend to deemphasize developmental limitations and emphasize more the role of affect, intuition, and sociopolitical forces in learning. Further, holists stress the role of interest, self-concept, connectedness, trust, and expectations in learning..." (p. 404). Rhodes & Dudley-Marling (1988) state:

> Holistic teaching extends to all areas of learning and the curriculum. Holistic education is a philosophy of teaching.... Holistic teachers endeavor to place students' learning within the context of their own experiences. .... Holistic teachers do not fragment learning, nor do they divide and subdivide learning into artificial time periods. Just as holistic teachers encourage reading, writing, and oral language across the curriculum, they attempt to integrate all areas of the curriculum. .... Holistic teachers are themselves learners, learning with and from their students. At the same time, teachers are students of learning, regularly observing their students as they learn and respond to instruction. (p. xi) .... Holistic teachers respect the learning capabilities of students. They recognize that students will learn what is personally meaningful to them. For this reason, they carefully consider the literacy environment they create with students, striving to mirror the purposes, audiences, and materials of the literate world (p.xii).

Heshusius (1984) says that "The need for more meaningful ways of knowing, ... for a nonmechanistic, holistic, participatory view of knowledge in which facts, values, ethics and meanings are no longer artificially separated, is being articulated in nearly all fields of endeavor." (p. 367). She believes that teachers must work within the person's perception of meaning and purpose because learning occurs only when the learner perceives it as having a real purpose. "When learning is meaningful, students learn. In fact, in a meaningful environment, it is difficult to stop children [and adults] from learning" (Rhodes & Dudley-Marling, 1988, p. xi).

Constructivism: Constructivism is a theoretical concept about the nature of learning that regards knowledge as a construction of the learner. Piaget (1968/1970, 1970) is perhaps the best known architect of constructivist theory. (An excellent educationally oriented explanation of the theories of Piaget and his colleague, Inhelder, may be found in Gallagher and Reid [1981]; also see Gallagher & Wansart, [in press]). Special educators who adopt a constructivist approach regard learning as an active, self-regulated process of making meaning from experiences. Self-organizing ability and purposeful self-direction are considered inherent in the learner (Heshusius, 1984) and are critical in the learning process. Constructivists view learning as based on interaction with the environment, but not as direct transfer or taking in information from the environment (Gallagher & Reid, 1981; Kamii, 1985, 1989; Narode, 1987; Wadsworth, 1978).

Constructivists often presume that learning requires learners to pose problems for themselves (DeRuiter, 1990). The entire problem posing and learning process involves: 1) Having a self-initiated goal (posing a problem); 2) anticipating a means (procedure) for attaining that goal; 3) encountering a blockage (physical or mental) that prevents the goal from being reached; 4) experiencing disequilibrium (recognizing a "mismatch" between what was anticipated and what is being experienced); 5) voluntarily involving oneself in thinking about (abstracting from) the experience; 6) trying out new approaches that evolve from new understandings.

Most constructivists agree that teachers are important in the learning process, although there is no one teaching method for applying the concept of learning as construction. Numerous authors have suggested sets of teaching principles and strategies based on constructivism (e.g., Brooks, 1990; DeRuiter, 1990; Fosnot, 1989; Gallagher & Reid, 1981; Gallagher & Wansart, in press; Kamii, 1985, 1989; O'Loughlin, 1988; Poplin, 1988b). These suggestions typically highlight the teacher's role as a guide, a coach and a

collaborator. Ideally, the teaching process involves collaborative posing and solving of "real" problems--those that are significant and meaningful to both the teachers and the students--for which the teacher does not have ready-made solutions. In the context of studying these real problems, the "facts" (e.g., history, vocabulary, research, etc.) about it are studied. Problem posing is not limited to a process of discovery and is clearly not intended to result in goal-less "mucking about" in any direction the students may want to go. Rather, it involves posing problems in such a way that the students are able to set a clear goal for learning but it also allows for varied routes to reach the goal.

In addition to problem posing, teaching methods based on constructivism emphasize 1) allowing students to seek their own solutions, 2) helping students generate disequilibrium where their understanding is weak, wrong or absent, 3) providing opportunities for action and reflection, and 4) application and evaluation of solutions. These processes are carried out with much dialogue, probing, negotiation of ideas, questioning, suggesting of alternatives, acceptance of others' points of view, and so on. From a constructivist perspective, all learners must be provided opportunities for active, self-regulated learning in social contexts appropriate for individual abilities and needs.

Holistic Constructivism: The highly interactive teaching approach advocated above shows that constructivist teachers recognize that knowledge is not constructed in isolation. Rather, construction occurs in a social context where each individual's learning is significantly affected by the ideas and actions of others. Psychologists and educators appear to be increasingly recognizing the importance of social context in learning (Black, 1989; Newman, Griffin & Cole, 1989; Resnick, 1989; Rogoff, 1990), a concept based partly on Vygotsky's (1978, 1986, 1987) idea of a zone of proximal development. In this interpsychological construction zone (Newman, Griffin & Cole, 1989), learners "develop through participation in problem solving with more experienced members of the culture" and through "participation in activities slightly beyond their competence" (Rogoff, 1990, p. 14). Thus, the construction of knowledge is both inter- and intraindividual, both self-regulated and other-regulated in an inseparable way. Rogoff (1990) calls this a "transactional or contextual events approach" (p. 28) in which "...the whole does not equal the sum of the parts; the whole has an essential character and process that must be studied for itself. Human activity involves the roles of both the individual and the social world, inseparably involved in the meaningful and purposeful events of life" (p. 24).

Methods Used In The Class

Poplin (1988b) says, "[A holistic constructivist] view of the teaching/learning process shakes the very foundation of all we have built...." (p. 414). Although this may sound a bit overstated, I have found that holistic constructivism has significantly changed my approach to teaching. In the course described here, where much of the course content involves a study of holistic constructivism, I especially try to make the teaching methods consistent with this view. I try to follow principles taken from Poplin (1988b) who, in an effort to link holism and constructivism, suggested a set that includes the following:

- The whole of the learned experience is greater than the sum of its parts.
- The interaction of the learned experience transforms both the individual's spiral (whole) and the single experience (part).
- The learner's spiral of knowledge is self-regulating and self-preserving.
- All people are learners, always actively searching for and constructing new meanings, always learning.
- Learning often proceeds from whole to part to whole.
- Learners learn best from experiences about which they are passionately interested and involved.
- Experiences connected to the learner's present knowledge and interest are learned best (p. 405).

My colleagues and I have used these and other principles derived from the authors cited above as a basis for developing teaching practices in our program. Some important assumptions that we make about the teaching/learning process are described below.

Assumptions

We regard learning as primarily "top-down" not "bottom-up." This does not mean that learning is imposed from the top. Rather, it means that learning proceeds from wholes to parts to wholes as Poplin (1988b)

suggests. Students do not first learn all of the "basic facts" of the field in sequential fashion and then go on to the broader issues and ideas. They start with broad ideas and problems, learn the "parts" in the context of the whole and as needed to address those ideas and problems, and integrate those parts into the whole as they work on the broad ideas and problems.

For example, the first topic studied in class is "What is learning?" A part-to-whole approach might begin by presenting the students with a specific set of "facts" about learning drawn from research literature or perhaps the "facts" about how different theorists describe learning. Contrastingly, in our whole-part-whole approach we pose the topic in the question form above (i.e., "What is learning?") and have the students treat it as a problem for discussion. As part of the problem discussion, we bring in specific (but still "whole level") content about major epistemological positions (e.g.; empiricism, rationalism, constructivism). Within the hour, we move to specific learning tasks such as solving puzzles or math problems during the solving of which the students are asked to reflect on their own and other students' learning. The results of this learning experience are discussed and the students are asked to induce conclusions about learning. In the context of this discussion, appropriate opportunities are used to inform the students about theoretical and research "parts" related to their observations and conclusions. The students are then asked to relate all they have learned back to the broad theoretical ideas discussed earlier.

Whole-part-whole does not refer only to what happens in a particular class period, however. All the learning in the course may be thought about as following this general pattern. It takes many iterations of the above, with varying formats and problems, to help students develop from beginning understandings of the whole, to knowledge and understanding of the parts, to integration of the parts with the whole. Observation of students during learning leads me to believe that "whole-part-whole" doesn't describe the process completely. The process appears to be more a movement back and forth between wholes and parts as learning proceeds. Still, the overall picture shows students moving from broad understandings to searching out parts that fit the whole to relating the whole and parts together in integrative fashion.

A second assumption is that every problem and issue can be meaningfully worked on by students at different levels of understanding. Students' understandings of teaching and learning vary widely. Frequently, this leads teachers to the conclusion that the first teaching task is to get everyone to the same level; that is, to try to assure that everyone has the same set of facts from which to operate on a problem. This goal cannot be realized. Students will always have different understandings and their knowledge bases will vary widely. Teachers also conclude that students can't address the really hard questions meaningfully until they know the right facts. Our view is that students can address the big problems, those that are difficult for the most expert, and do so meaningfully, when meaningfulness refers to what is meaningful to the learners and helpful for their learning. The way they actually address such problems provides the teacher with needed information about what the students still need to learn. The very process of struggling with difficult problems stimulates the need to know and efforts to learn.

Closely linked to the above assumption is another: That every learner has important knowledge to contribute to the group. We try to take advantage of students' differences in knowledge and skills, not to eliminate or ignore them. Using the above example of the "What is learning?" problem, we assume that everyone has some meaningful ideas about the question. Some will be more integrative thinkers; some will have more specific knowledge; some will have more practical knowledge; some will know much more about theories than others; but all will know *something* and the contributions of each one affect learning for everyone. The professor is not the only teacher in the room.

We also assume that students will be at different levels of understanding when they begin and end the course. Although we may *offer* a common curriculum to all of the students they will not take the offer equally. We do not pretend that every component of content that is "covered" in the course will be understood or used equally well when students complete it. Rather, each student will develop a unique set of skills, insights and understandings related to his or her personal goals and abilities. Certainly, some commonality exists because the students have many similar goals. But we are not surprised to find important differences in our students when they complete the course.

Finally, we assume that students will not understand the course content completely. They will not reach the level of understanding of the professors. This is not easy to accept. We nearly always hope our

students will learn more than they do. As best we can, we avoid bemoaning the ignorance of the students. We try to remember that the students will continue to learn after they leave the class. We try to remember how much more ignorant we were at their stage of schooling and experience. This assumption seldom reduces our compulsion to teach as much as we can, but it does reduce our concern and guilt when we find that students end the course with limited understanding.

Some Rules of Thumb

Our epistemology, principles and assumptions come together in some "rules of thumb" that we follow to decide on content and methods for the class. We do not see these as hard and fast guidelines but as helpful directions that can be taken. Some of our rules are presented below.

Students and teachers should be mutually involved in the processes and goals of education. Students should help decide on course content, on which problems to solve, and on the desired outcomes. This does not mean that course content is controlled by the students but that they are in on the decisions. Course content and processes are negotiated, not dictated, but the teacher makes full use of her knowledge of the domain to direct the students toward her perceptions of what is most critical.

Instructors need clear goals for learning but must allow alternative routes for getting to the goals. Students have power to choose which assignments they do and how they do them. We also encourage students to decide who the audience will be for their work, which moves the focus away from what the teacher wants and toward their personal goals. The first half of this rule is very important, too. Our experience with students shows that they often regard constructivism as dictating teaching that has no clear goals except for hoping that the learners will discover something as they work on problem solving. This is not the view we take at all. Rather, we believe the teacher must have very clear ideas about what she wants the students to learn. For example, in the class described here we want our students to know major epistemological approaches, their implications for teaching, how they can be applied to teaching, specific application skills, and so on. This is not a "whatever you learn is OK" approach. However, the precise way in which the students learn and apply their learning is highly individual and variable.

Eliminate tests and grading. The university does not allow elimination of grades but we do so by assigning "A" grades to everyone at the beginning of the course. The only conditions are class attendance and redoing assignments if asked to do so by the instructors. This takes away the false pressure and needless anxiety of grades but retains a high level of performance. Tests are eliminated and replaced by assignments that are as similar as possible to tasks we face in the world outside of school. On the job, teachers are not given tests. Instead they are expected to complete specific tasks, including teaching their students. We try to duplicate this by evaluating performance on significant tasks, not on contrived tests. Even in this evaluation, though, the focus is on communicating effectively, on learning, on careful observation and analysis, on understanding why, and on teaching that results in learning for the students being taught. Far less emphasis is given to getting it right or finding out what someone knows.

Reduce the curriculum to essentials. The focus of the course is on problems, issues, and major topics rather than on facts, chronology and skills. The latter are made available and used, but are not the focus of learning. Frequently, students learning about holistic constructivism complain that there is not enough time to teach that way. They say that this theory implies teaching that focuses on understanding, not just skills and that this kind of learning takes a lot of time. We agree. Further, they believe the theory requires lots of time for students to discuss, try out their ideas, make false starts and errors, and so on. Again, we agree. Invariably, another student suggests that even if it takes a lot of time, it is worth the time if the learning is longer lasting and more broadly applicable. With all of this we agree, but we think one more idea can be added: School curricula can be dramatically reduced under this approach. Rather than reducing the curriculum to thousands of minute items, this approach encourages identifying the "hard things", a term suggested to me by Judith Gilbert (personal communication). These hard things are the broad understandings that cut across numerous specific skills and ideas.

For example, Judith Gilbert and I have identified two hard things for elementary students to learn about math. These are: 1) An understanding of cardinality and ordinality and how they are related; and 2) an understanding of how to "break apart" and "recombine" quantities. These two concepts are needed to understand all of the major ideas and operations of math that are usually taught in elementary school. Counting, grouping, place value, addition, subtraction, multiplication, division, fractions, decimals--all can

be taught quickly and easily if these two concepts are understood. If all of the children's problem posing and solving focuses on understanding these concepts, they are more likely to develop both understanding and skills. Kamii (1985; 1989) found young children to be more advanced (compared to traditionally taught peers) on assessments of understanding and equally able on typical skill tests when they were taught with "constructivist" methods. The problem for teachers who think that time is too limited is that they regard "learning to understand" as another addition to a curriculum that is already impossibly large.

Use problem posing extensively, with the focus on "real problems" (those that are real to the instructors as well as the students). Notice that problem *posing*, not problem *solving*, is the focus here. Knowing how to formulate important problems is regarded as a very significant skill and problems cannot be solved if they are not first posed. The students help with the posing so the problems are based on their needs and goals as well as those of the instructor. Ideally, the problems are not those for which the instructor has already prepared answers. Bateman (1990) provides a nice example when he asks students what they can make of a one-paragraph description of an excavated 15,000 year old human skeleton. First, Bateman denies the students the benefit of his expert analysis so they will have the opportunity to develop their own ideas. More relevant to this topic, he has presented a problem that he cannot answer fully. Even with very young students, teachers can do this. We teachers might be surprised how often we learn something new when we ask kids, "How many ways can you think of to put these ten objects in groups?"

Focus on action, field work and trying things out in meaningful contexts. Although mental "action" is even more critical than physical, we try to center the learning in an action context where teachers frequently solve real problems as they teach children. We start with field work, using it as the location for careful observations and as the basis for making inductive conclusions. This contrasts with learning in isolation from action and with using action to try out or confirm ideas presented in class. Much time is spent in analysis and reflection on the actions that have been carried out.

Regard students as going through a developmental process during the program. Students and professors both tend to think of students as either knowing or not knowing. Our approach is to think of the students (and ourselves) as developing learners whose knowledge will always be partial. Additionally, we are able to concentrate on helping students develop to the next phase of understanding when we think of them as in process. We make fewer mistakes, such as trying to force them to understand something that is two phases higher than they are now.

Some Examples of Processes

Although I am still learning new ways of teaching the class, the following are some of the ways the students approach the content in the class. I have not attempted to be exhaustive but to show some of the major options used so far.

--Students videotape themselves teaching and critique their tapes with the instructor and other students.
--Students form cooperative learning groups for discussions, problem posing and solving, completing assigments, etc.
--Students write logs, analyze their own learning processes, focus on awareness of their own learning.
--Students decide on specific goals and means of reaching them for each class.
--Problems are posed by students and instructors in collaboration. The content of the course is studied in the context of seeking solutions for the problems.
--Students do teaching experiments of their own design.

The essence of these activities is found in the sense of community, of collaboration and cooperation, that is built as the activities are developed and shared. Learning for the sake of the instructor is not the goal. As the teacher, I seek to avoid being the focus of the activities that lead to learning. Developing self-awareness and self-evaluation, growth in understanding, and involvement in the processes are emphasized. The students are both doing activities that are personally meaningful and reflecting on what they have done. The hope is that they are learning for themselves, with others and for the sake of the students they will teach.

DATA COLLECTION AND ANALYSIS

In addition to field notes, four main information sources are being used in this study: 1) Written statements at the beginning of the course; 2) video tapes and written comments about them; 3) written statements at the end of the course that parallel those at the beginning; and 4) an individual interview at the end of the course. Each of these is briefly described below.

Beginning written statements. At the beginning of each semester, the students are asked to write one-paragraph responses to each of the following items:

-What is learning?
-What is the nature of human development?
-What is teaching?
-Why do some students learn more and others less?
-Describe yourself as a learner.
-Describe yourself as a teacher.

These responses provide information about how the teachers understand the teaching/ learning process at the beginning of the semester.

Video tapes. During the semester, the students video tape themselves as they work with children. These tapes are viewed and discussed by the instructor with small groups of class members. The instructor records field notes during the viewing and discussion. Following the viewing, each student writes an analysis of his or her teaching after receiving written and oral comments from the instructor and other students. This analysis follows a format provided by the instructor. In some semesters the students made a second video tape later in the semester and repeated the above process. A second tape was assigned at the request of the students, who told us after the first tape that they wanted to do it again because "Now I understand how I can do much better." However, analysis of the second set of tapes did not add significantly to our understanding of what the students had learned. They did, indeed, "do better" by some of the criteria we used, thereby showing a higher phase of understanding, but other data sources showed the same information. Thus, although the students continue to film a second round at their option, we no longer use them for the study.

Ending written statements. At the end of the semester, the students again write one-paragraph responses to the first four items specified above for their first paper. For the last two items, slight modifications are used as follows:

-Describe what you have learned about yourself this semester.
-Describe how you have changed as a teacher during this semester.

Individual interviews. Finally, each student participates in an individual interview with the instructor. Before the interview they are told that they will be asked the following four questions and they are asked to write brief responses to them:

1. What are the most important concepts you have learned in this class and why are they important to you?
2. What questions do you have about the course content?
3. How do you evaluate your progress and learning in this class in terms of your learning and understanding of the major concepts?
4. What other comments or suggestions do you have regarding the course and instructors?

Again, field notes are recorded by the instructor during the interview.

These information sources are reviewed by a research team. Our initial efforts are focused on reading the students' written comments and the field notes for the purpose of developing assertions about the data. This part of the analysis is currently under way, with several tentative assertions developed. Our next phase is to seek confirmation/disconfirmation of these assertions.

ASSERTIONS ABOUT THE DATA

The assertions presented here are tentative. The information sources are not completely analyzed and the assertions await confirmation/disconfirmation based on additional data collection. The reporting approach used here is to state the assertion, describe it and provide examples of its basis in the data. The examples are chosen because they are reasonably articulate expressions of concepts or ideas that are found

throughout the data. They are quoted verbatim, including grammatical errors (but with corrected spelling in the written version). Only two assertions, those that I regard as most significant for this symposium, are reported here because of time limitations.

Assertion 1

As students go through the semester, they progress through qualitatively different phases of understanding. The notion of qualitatively different phases is certainly arguable. However, the data indicate that this is a helpful way to look at the students' learning. Their own statements, the video tapes and the field notes indicate that they see their learning, or even more, their approach to teaching, as a transformation, not only as an increase in understanding. They not only know more, they know differently. The following quotation from Dawn's final interview illustrates the general concept of qualitative change:

> This class has really had an impact upon my beliefs and practices as a teacher. I am eager to return to school and experiment with some of the new concepts that I have acquired. ... In the past I've always just taken suggested techniques and perfected them because someone has said they work the best or I have observed them and thought that they were effective. Now I look at learning much differently. ... It is amazing to me that my attitude about learning theories could change so dramatically in such a short time. ... I hope to reconstruct my strategies in an effort to facilitate and encourage my students to be more autonomous and life-long learners. ... In retrospect, I am pleased with my learning progress. I found myself constantly applying concepts discussed in class in many other experiences. ... I appreciate the approach that the instructors took, and view this class as a very qualitative rather than quantitative experience.

Assertion 1 also points out that qualitative change occurs in phases. Although this part of the analysis is particularly open to changes in specifics, we have so far identified four major phases that characterize what happens to the students' thinking and teaching. Essentially, we are beginning to regard teachers as evolving developmentally as they go through our program and transform their understanding and ability to apply the concepts from the class. These phases center particularly around their understanding of constructivism and how it might be applied to teaching. The concept of "constructivist teaching" is usually new to the students and therefore an especially obvious focus for changes in understanding and practice. Students do not all start nor end at the same phase as others and some make more progress than others. The phases we have identified are:

Phase I: "Dawning awareness" phase. Students begin to recognize that constructivism exists as a theory of learning. They ask, "Could it be?" They often get that sinking feeling, "It could be (and my teaching has been all wrong)." Some go through "It couldn't be" and show some form of resistance to change. In this phase, students may show considerable anger and resentment toward the instructors. Most say, "I have no idea how to 'do constructivism'." Frequently, this phase is most obvious in the students' analysis of their video tapes, although similar statements are found in the beginning written statements. Nan, an experienced teacher, seems to recognize in the following comment that somehow one can be "more constructivist" and that this is probably different from what she did before. However, she cannot yet imagine what she needs to do to change.

> I never heard of constructivism before so I have no idea how to apply it. I don't see how you can expect us to make a video tape about something we don't understand. It seems like you want us to fail. I am in complete disequilibrium because I did such a terrible job on my tape but I don't know how to be more constructivist.

Phase II: "Black and white" phase. Students focus on the practice (procedures), not the theory, and they regard the "methods of empiricism" and the "methods of constructivism" as direct opposites. They think, "Constructivism is really different" and they believe that specific methods are suitable only for one, not the other. Three ways of responding are common in this phase: 1) I need to change; 2) I don't want to change; and 3) I've been doing constructivism all along. When they teach, two general approaches are common: 1) Ask a question, then revert to telling the students the truth; and 2) ask a question, then leave the students on their own. It has become obvious to the instructors that in this phase the students seldom meaningfully understand the idea that *theories* about learning and *methods* based on theory are not the same thing. A student has never expressed this concept and they continuously make comments that indicate a

sort of "theory-methods isomorphism." Stephanie's response to the question "What do you think is the essence of constructivist theory?" shows Phase II thinking:

> Empiricists always lecture. They never give students a chance to think for themselves. Constructivists always ask questions and let the students answer them.

This comment illustrates both an emphasis on a very clear difference between the two positions and on equating theories with methods. Another student, Jeff, placed a little less emphasis on the differences between the theories, but still clearly showed that he was thinking of them as implying specific methods that would not be acceptable to theorists from the other camp. He said,

> I'm finally getting clear on which methods go with which theory. Cooperative learning and letting students find their own answers go with constructivism and I'm trying to learn how to do them better. I guess I've always been an empiricist with my methods in the past.

That students in this phase focused strongly on the procedures or teaching methods rather than the theory is indicated by many verbal and written comments both during and at the end of the class. Diane's comments are typical:

> I feel we didn't get enough guidance on how to really apply constructivism before we did the video tapes. We should have had more examples of exactly how to do it. I think more actual classroom models of how to use constructivism with a pre-set curriculum would be valuable. "Here's what I have to teach--How can I do it constructively?"

In this phase, students want examples and demonstrations. They do not seem to think of themselves as a good source for creative approaches to teaching. They do not talk about or ask about the theories, trying thereby to gain new insights into how the theory might be applied. They are not yet thinking of themselves as scientists. They tend to show a strong lack of insight into the theory of constructivism and its implications for their own learning. They often see themselves as "taking in" information from the environment and seldom recognize that this idea conflicts with constructivist theory.

Phase III: "There's really more to it than I thought" phase. Students begin to realize that constructivism requires a revolution in the way they think about learning and teaching. Simultaneously, they begin to separate theory and practice. They recognize that constructivism does not necessarily require particular methods and that many specific ways of implementing a constructivist approach are possible. Often, they are able to say more than they can do. When they talk, they seem to have a deeper understanding than in Phase II. They often say, "I get it now!" but when they teach, little difference is apparent from Phase II. Francis made the following written comment on her final interview sheet:

> Learning in all individuals is active. The various teaching methods each have a place in learning. Now I'm more aware of which method I am using. Frequently, E & C (empiricism and constructivism) are combined. I don't feel that either method is preferable, each has their place. I feel I have come a long way toward understanding generally the major concepts introduced in this course, however it is still rather mechanical to me, doesn't come easily or naturally yet.

Stacey makes a comment that shows her awareness that she is still learning even though she thinks she understands the basics:

> [The most important concept I have learned in this class is] Constructivism and the idea that when children are in disequilibrium a structure can be created by the student. Each child has different needs and should construct their own structure. Teacher as facilitator!! Ask questions!! I'm getting better at it but it's hard. I still think that I have to give answers and stop failure a lot of times. I can't let go and help the kids find their own way. I'm just starting to learn that I can use almost any method, depending on the child, if I can just remember that he has to learn it for himself.

When we observed a second video tape with Stacey, her methods were virtually identical to her earlier effort. However, she clearly recognized this as a problem and expressed her continuing need to learn how to apply the theory.

Phase IV: "This is hard, but I can do it" phase. Students begin to apply the concepts of the class in ways that integrate procedures with theory. They recognize that they have only a partial understanding while gaining confidence in their ability to "apply constructivism" in creative ways that are meaningful to them. Their teaching practices show more careful listening to students, more awareness of how the learner is

thinking and creative interaction with the students in ways that help them learn. Dawn, quoted earlier, again provides a typical example:

> I truly do believe that presently we are directing our students towards being dependant upon achieving the "right answer" rather than being concerned with how they achieve the answer. I see myself as a prime example of these practices. I wanted the answer and if I didn't get it I would quit in frustration. This was my experience when I signed up for the course last spring. I thought the bicycle problem [a problem posed in the class] was a useless activity that had no relation to my teaching career, therefore I dropped the course.

Dawn goes on to describe her experience with teaching a profoundly handicapped adult to make a milkshake:

> He "constructed" a shake as he thought it should be. He then tasted it and found that it had too much chocolate...the crucial moment of disequilibrium was upon him. We then discussed why it would be called a "milk shake", and he was able to determine that it needed more milk and more ice cream.
>
> As a teacher, I found it difficult to not give him the answers and let him make mistakes, but overall I found that the lesson was successful and he retained his knowledge. He was able to do it "his way" and received reinforcement for the process rather than the product. He was very proud of himself....

Barb talks about the importance of attending to how children think and then using theory to guide her responses:

> The most important thing I learned is constructivism and how children think. I've noticed that I'm more aware of how children are thinking and I ask more questions to promote thinking, disequilibrium, and learning concepts by figuring them out themselves. I also notice how other teachers teach and the questions they ask.

Connie says:

> [The most important concept I learned is] being exposed to the constructivist methods that is concerned about finding out how a child thinks. I have already applied this to my teaching in that I'm trying to use a few constructivist words. I also am interested in how a child thinks now. I had never really considered this idea and expected to understand how they think. This is important if I want to help a child reach a different level.

Phase IV seems to be a good starting place for the continued development of creative approaches to teaching. We are just beginning to collect data about how teachers are using the theory and techniques learned in the class as they work in practicum settings in their next semester of graduate work. One question of interest is whether our classifications of students in higher or lower phases is related to the effectiveness of their teaching.

Assertion 1 and Pedagogical Content Knowledge

How does the development described here relate to the concept of pedagogical content knowledge? The students, without exception in the 106 individuals studied so far, end the semester showing a higher phase of understanding than at the beginning. They rather clearly seem to have learned something important about teaching. Does this mean that they have developed new pedagogical content knowledge? Or is only *pedagogical* knowledge being developed? Although this has not been the focus of the study, I have some partially formed ideas about these questions.

The first idea is that teachers are more likely to develop PCK if they focus on how children think and learn. When the teachers make video tapes they almost invariably choose to teach in a content area in which they are very knowledgeable. Since most are also highly experienced teachers, I would expect them to have considerable pedagogical content knowledge about the lesson. The missing element usually seems to be a deep understanding of the thought processes of the children, in relation to the specific content or problem being taught. I suggest that the least understood and most critical aspect of pedagogical content knowledge is this understanding of one's students. Without this understanding, PCK is a useful but general concept, a knowing only of what *generally* works with this content and these students. This knowledge is not necessarily helpful for a specific child or group of children.

Certainly, more than understanding of children's thinking and learning is needed to develop PCK. For example, as I look at our students' development, I see changes taking place only when they 1) are allowed

time to struggle, 2) apply their ideas directly in teaching important content to real kids, and 3) go through a number of "phases" related to integrating theory and practice. I suggest, however, that understanding the thinking and learning of one's students is critical to the development of PCK. My reading of the teacher education literature shows this aspect of PCK to be, at best, only a small part of most teacher education programs.

A second idea is that a theoretical position like holistic constructivism, if both taught and modeled, may aid the development of PCK. We were not trying to "teach PCK" in the class described here, but when we saw video tapes in which the match between a child, a teacher and a difficult concept clearly resulted in learning, we saw PCK in action. When a student says, as one did to Pam, "How did you know I was thinking that? You can almost read my mind!", we have a good indication that the teacher has a high level of awareness of what the child is thinking. Phase IV students like Pam seemed to almost intuitively know how to make integrative teaching decisions that lead to effective learning for their students. To us, it seems that this ability is developed fairly rapidly when the focus of learning is the child, not the content, and when the teachers are placed in real teaching contexts where they are asked to focus on relationships between theories of learning and how they might apply to teaching.

Further, we speculate that a theory such as holistic constructivism is especially helpful in developing PCK because it values and emphasizes self-regulation, personal responsibility and self-analysis, all of which encourage teachers to reflect on their teaching effectivness. But this speculation goes considerably beyond the scope of our data so far and remains to be tested.

Assertion 2

Learning to teach is an holistic process. Our students did not seem to learn piece by piece, part by part. Rather, when they came to new understandings, a transformation of their learning was evident. The transformation was not necessarily sudden, but it was often dramatic.

It was not uncommon for students to say, in their final interview, that they had powerful feelings of fear, anxiety, anger and hostility early in the class. They could not understand what we were trying to do. They did not know what we wanted. They felt lost about the course content and expectations. Over the course of the semester they develop through one or more new phases, each a transformation of learning, to an understanding that goes beyond these negative feelings. Typically, this change is obvious in their comments and reflects an understanding that they have changed in many ways, not just in their emotional reactions to the course. Jackie's comments illustrate this, although they still show some reluctance to accept the changes:

> For the first three weeks, I really hated this course and I was furious about your refusal to tell us answers to some of our questions. For a while I almost gave up and quit trying, but I was too mad. I decided I would show you. I would learn this stuff and prove that it wasn't the best way of teaching for everybody. It wasn't until almost the end of the semester, after I understood constructivism a lot better and really saw how it worked that it dawned on me--I went through the very process of reconstructing my knowledge that we had been talking about all along. Maybe, for a behaviorist like I was, it's necessary to struggle this hard. I can see how my teaching and thinking have changed in many ways even though I'm not entirely happy about it all yet. Could it be this was your idea all along? I think instead of disproving your theory, I proved it!

Jackie appears to have been unaware of our concern about her anger (Yes, she had let it show.) and seems to have forgotten our efforts to help her, which, from our perspective, she rejected. We are not surprised that she saw the struggle as difficult and perhaps necessary, given her starting place and personal characteristics. Of interest here, however, is her insight into how she has changed in many ways. Not only her emotional responses, but also her teaching and thinking have changed.

A few students showed a similar understanding but were unwilling to change their approach. That is, they believed that "constructivist teaching" required holistic changes but were not convinced that they wanted to make the changes. Interestingly, these students sometimes showed advanced (e.g., Phase III or IV) thinking about teaching and learning. They made comments such as this one by Aaron:

> I see how constructivism can be applied and that it might be useful for some situations or teachers--maybe certain personality types. I am trying to pay more attention to how my kids learn and I think I could use many of the methods if I wanted to. But I'm not ready to make "the big change" because I'm still convinced that the way I teach now is very effective for my kids and my subject.

It is tempting to think that if Aaron *really* understood constructivism he would make "the big change." However, this position contradicts a central constructivist notion that people construct their own, self-regulated version of reality and that version is both legitimate and valid. I prefer to focus on Aaron's idea that the change is "big", that it is holistic in that it would affect his entire approach to teaching and learning. As we observed students' progress through the phases, each phase affected everything they did and thought, not just some small part.

Assertion 2 and Pedagogical Content Knowledge

What have I learned about PCK from this analysis? Again, I will risk a speculation about PCK, one based on the idea that change is holistic. My idea is that PCK develops simultaneously with transformations of understanding of content knowledge and pedagogical knowledge. Pedagogical content knowledge is not an addition to the other areas of knowledge but a part of the transformation of the whole.

CONCLUSION

In summary, what I have learned about PCK through the processes described here leads me to a set of ideas similar to the working hypotheses suggested by Cochran (Cochran, King & DeRuiter, 1991) earlier in this symposium. I will not repeat those ideas here. Rather, I will conclude by pointing out the potential importance of three ideas that may impact the development of PCK.

The first idea is that teachers will ground their development of PCK in an epistemological stance. Teachers' views of the nature of knowledge and its development directly affect how they go about the teaching/learning process. If this is so, prospective teachers may be enabled to develop their PCK by making their epistemology explicit, by studying alternative positions and working on how to apply them, by observing others who are basing their teaching on particular epistemological positions and so on. Reflecting on one's beliefs about epistemology and about corresponding applications and making one's epistemology explicit may be particularly helpful for the development of PCK.

Second, teachers' understanding of students' specific thinking and learning strategies, in the context of learning particular concepts and skills, is central to the development of PCK. Although the literature on PCK clearly expresses this idea, I submit that teacher educators seldom thoroughly integrate the concept into their programs. For example, evaluation of students' learning often focuses on outcomes and products, not on learning processes. In fields such as special education, we often focus on reasons for failure and on what students do not know rather than on what they know and the strategies they effectively use to learn. Several years ago, Siegler (1978) noted an "apparent trend is the increasing focus on what children of given ages *can* do rather that on what they cannot do" (p. x). Since that time, this trend has accelerated and much has been learned. Teachers' PCK development may increase significantly if we take advantage of this literature and integrate it into our programs.

Finally, I think we will find that students will develop PCK more effectively and efficiently if we regard them (and they, in turn, regard their students) as learning in holistic ways through qualitative transformations of their understandings. Obviously, my epistemological biases show here and this idea needs empirical testing. But it seems to me that PCK is a highly integrative, holistic concept. Perhaps an epistemology that is similarly holistic and integrative will help in its development. At least, it seems to me to provide a useful perspective from which we can study the development of PCK and a meaningful alternative to the empiricism that is predominant in most teacher education programs.

In short, I believe we can help teachers develop PCK by enabling them to 1) make their epistemology explicit, 2) study students' specific thinking and learning strategies and 3) understand learning as an holistic process that proceeds through qualitative transformations or phases. For me, these ideas, combined with Cochran et. al's (1991) working hypotheses, provide a reasonable starting place for working with teachers on this important area of their development.

REFERENCES

Bateman, W. L. (1990). *Open to question.* San Francisco, CA: Jossey-Bass Inc.

Belenky, M. F., Clinchy, B. M., Goldberger, N. R., & Tarule, J. M. (1986). *Women's ways of knowing: The development of self, voice and mind.* N.Y.: Basic Books.

Black, A. (1989). Developmental psychology as core knowledge for elementary school pedagogy and teacher education. *The Genetic Epistemologist, 17,* (4), 1-3.

Britzman, D. P. (1986). Cultural myths in the making of a teacher: Biography and social structure in teacher education. *Harvard Educational Review, 56,* 442-456.

Brooks, J. G. (1990). Teachers and students: Constructivists forging new connections. *Educational Leadership.* March. 68-71.

Carnegie Forum on Education and the Economy. (1986). *A nation prepared: Teachers for the 21st century.* N.Y.: Carnegie Foundation.

Cochran, K. F., King, R. A., & DeRuiter, J. A. (1991). Pedagogical content knowledge: A tentative model for teacher preparation. Paper presented at the American Educational Research Association, Chicago, IL.

Confrey, J. (1985). A constructivist view of mathematics instruction. Part I: A theoretical perspective. Paper presented at the American Educational Research Association, Chicago, IL.

Confrey, J., & Upchurch, R. (1985). A constructivist view of mathematics instruction. Part II: An empirical examination. Paper presented at the American Educational Research Association, Chicago, IL.

DeRuiter, J. A. (1990). Suggestions for constructivist teaching. Unpublished manuscript. Greeley, CO: University of Northern Colorado.

DeRuiter, J. A. (1991). Consumer involvement and changing faculty roles. Unpublished manuscript. Greeley, CO: University of Northern Colorado.

DeRuiter, J. A. (1991). Faculty roles and changing theories in leadership education programs. Unpublished manuscript. Greeley, CO: University of Northern Colorado.

Forness, S. R. (1988). Reductionism, paradigm shifts, and learning disabilities. *Journal of Learning Disabilities, 21,,* 421-424.

Fosnot, C. T. (1989). *Enquiring teachers, enquiring learners: A constructivist approach for teaching.* N. Y.: Teachers College.

Franklin. B. M. (1987). *Learning disability: Dissenting essays.* N.Y.: Falmer.

Gage, N. L. (1989). The paradigm wars and their aftermath: A "historical" sketch of research on teaching since 1989. *Educational Researcher, 18,* #7, 4-10.

Gallagher, J. M. & Reid, D. K. (1981). *The learning theory of Piaget and Inhelder.* Austin, TX: Pro-Ed.

Gallagher, J. M. & Wansart, W. (in press). A Piagetian assimilative base model of strategy-knowledge interactions. *Remedial and Special Education.*

Governors' 1991 Report on Education. (1991). National Governors Association, Washington, D. C.

Goodlad, J. I. (1983). *A place called school: Prospects for the future.* N. Y.: McGraw-Hill.

Heshusius, L. (1984). Why would they and I want to do it? A phenomenological view of special education. *Learning Disability Quarterly, 7,* 363-368.

Heshusius, L. (1991). Curriculum-based assessment and direct instruction: Critical reflections on fundamental assumptions. *Exceptional Children, 57,* 315-328.

The Holmes Group. (1986). *Tomorrow's teachers.* East Lansing, MI: Author.

Kavale, K. & Forness, S. (1985). *The science of learning disabilities.* San Diego: College-Hill.

Kamii, C. (1979). Piaget's theory, behaviorism, and other theories in education. *Boston University Journal of Education, 161,* 13-33.

Kamii, C. K., with DeClark, G. (1985). *Young children reinvent arithmetic: Implications of Piaget's theory.* New York: Teachers College Press.

Kamii, C. (1989). *Young children continue to reinvent arithmetic: 2nd grade.* N.Y.: Teachers College Press.

Kuhn, T. S. (1970). *The structure of scientific revolutions* (2nd ed.). Chicago: University of Chicago Press.

Narode, R. B. (1987). *Constructivism in math and science teaching.* ERIC Document Reproduction Service NO. ED 290 616.

Newman, D., Griffin, P. & Cole, M. (1989). *The construction zone: Working for cognitive change in school.* N.Y.: Cambridge University Press.

O'Loughlin, M. (1988). Reconceptualizing educational psychology to facilitate teacher empowerment and critical reflection. Paper presented at the Annual Meeting of the Midwestern Association for Teachers of Educational Psychology. Bloomington, IN.

Piaget, J. (1970). *Genetic epistemology.* N.Y.: Columbia University Press.

Piaget, J. (1968/1970). *Structuralism.* N.Y.: Basic Books.

Poplin, M. S. (1988a). The reductionistic fallacy in learning disabilities: Replicating the past by reducing the present. *Journal of Learning Disabilities, 21,* 389-400.

Poplin, M. S. (1988b). Holistic/Constructivist principles of the teaching/learning process: Implications for the field of learning disabilities. *Journal of Learning Disabilities, 21,* 401-416.

Reid, D. K. (1988a). Reflections on the pragmatics of a paradigm shift. *Journal of Learning Disabilities, 21,* 417-420.

Reid, D. K. (1988b). *Teaching the learning disabled: A cognitive developmental approach.* Boston: Allyn & Bacon.

Resnick, L. B. (Ed.). (1989). *Knowing, learning, and instruction: Essays in honor of Robert Glaser.* Hillsdale, N.J.: Lawrence Erlbaum Associates.

Rhodes, L.K. & Dudley-Marling, C. (1988). *Readers and writers with a difference.* Portsmouth, N. H.: Heinemann.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context.* N. Y.: Oxford University Press.

Siegler, R. S. (Ed.). (1978). *Children's thinking: What develops?* Hillsdale, N.J.: Lawrence Erlbaum.

Sigmon, S. B. (1987). *Radical analysis of special education.* N.Y.: Falmer.

Sirotnik, K. A. (1983). What you see is what you get--consistency, persistency and mediocrity in classrooms. *Harvard Educational Review, 53,* 16-31.

Skrtic, T. M. (1986). The crisis in special education knowledge: A perspective on perspective. *Focus on Exceptional Children,* March, 1-16.

Smuts, J. C. (1926). *Holism and evolution.* N.Y.: McMillan.

Teachers for the future: A university-wide curriculum design. (1990). Greeley, CO: University of Northern Colorado.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.) Cambridge, MA: Harvard University Press.

Vygotsky, L. S. (1986). *Thought and language.* (A. Kozulin, Ed.) Cambridge, MA: MIT Press.

Vygotsky, L. S. (1987). *The collected works of L. S. Vygotsky. Vol. 1: Problems of general psychology.* (R. W. Rieber & A. S. Carton, Eds.) N.Y.: Plenum Press.

Wadsworth, B. (1978). *Piaget for the classroom teacher.* White Plains, N.Y.: Longman.